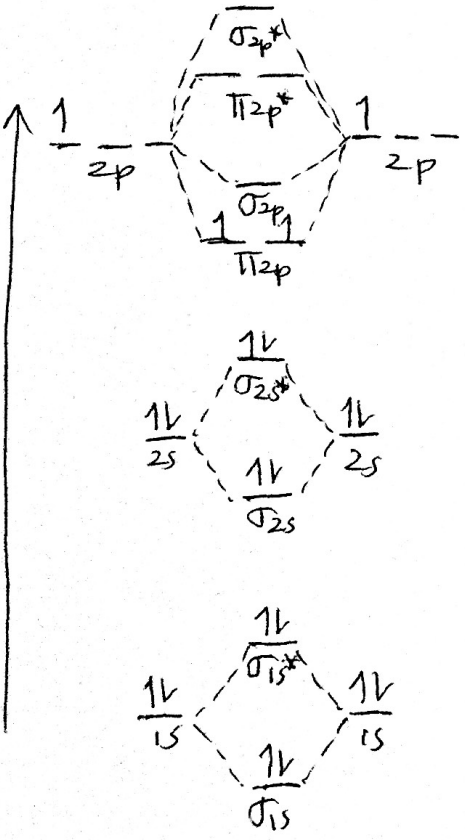
Chemistry 129.01 Quiz #6 – 25 points

Name: Key

Solve the following problems:

1. (16 pts.) Consider the B_2 ion.
   - (a) Draw its molecular orbital diagram and write its electron configuration.
   - (b) What are the shapes of the molecular orbitals σ_{2p} and σ_{2p}^* ?
   - (c) Determine its bond order. Is B_2 stable? Is B_2 paramagnetic or diamagnetic?
   - (d) If two electrons are added to form B_2^{2-}, how many unpaired electrons would B_2^{2-} have? Calculate the bond order of B_2^{2-}. Which would you expect to have the stronger bond, B_2 or B_2^{2-}? Longer bond? Explain

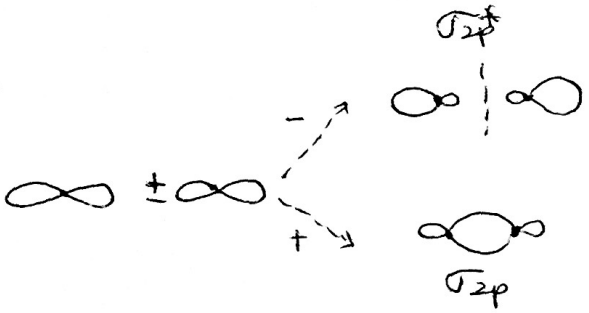
(a)



Electron Configuration:

$\sigma_{1s}^2 \sigma_{1s}^{*2} \sigma_{2s}^2 \sigma_{2s}^{*2} \pi_{2p}^2$

(b)

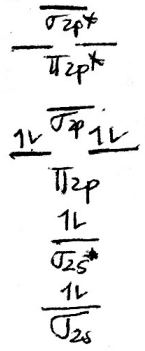


(c) $B.O. = \frac{1}{2}(6-4) = 1$

Bond Order is $> 1 \Rightarrow$ Stable

B_2 has two unpaired electrons $\Rightarrow$ Paramagnetic

(d) B_2^{2-} has no unpaired electrons → B_2^{2-}



$B.O. = \frac{1}{2}(8-4) = 2$

B_2^{2-} has a greater bond order so it has a stronger bond

B_2 has a lower bond order so it has the longer bond

2. (5 pts) The IR spectrum of ammonia vapor shows a bending vibrational mode band at $\tilde{\upsilon} = 950\ cm^{-1}$. Calculate wavelength (in nm) and the energy of the photon absorbed.

$$\lambda = \frac{1}{\tilde{\upsilon}} = \frac{1}{950 cm^{-1}} = 1.1 \times 10^{-3} cm = 1.1 \times 10^{4} nm$$

$$E = (6.626 \times 10^{-34} J \cdot s)(3.00 \times 10^{10} cm/s)(950 cm^{-1}) = 1.9 \times 10^{-20} J$$

3. (4 pts) Based on our discussion of Session 6 of the greenhouse gas module, which of the following would you predict are greenhouse gases: CO_2, O_2, and H_2O? Explain.

CO_2 & H_2O are greenhouse gases. They have dipole moments that change during vibration so they are IR active.